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WHERE'S the BEEF in JOINT SEALANTS?

Hybrids Hold the Key

By Lester Hensley

When Captain Richard King established the King Ranch in Southeast Texas in 1853 the only cattle that could stand the harsh heat and scrubby terrain were Indian Brahmans or "Longhorns". But Longhorns are lean and don't make great beef. The British Short-Horn made great beef but couldn't take the heat. King's solution was to cross the breeds resulting in the first-ever American breed, the Santa Gertrudis which features great beef and the ability to thrive in hot, harsh climates.

Not unlike Captain King's frustration with finding the right cattle to make his ranching business successful, we in the sealing and waterproofing industry have got to be a little frustrated with the performance of our sealant material options.

Liquid sealants suffer from numerous installation and material challenges in getting them to work properly, and preformed sealant alternatives are fussy to size and install.

Where's the Beef in Joint Sealants?
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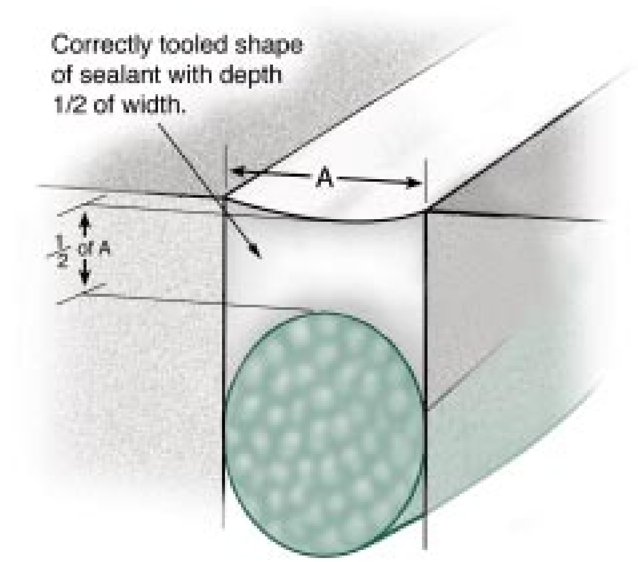

Figure 1: Proper positioning of backer rod and tooling of liquid sealant to achieve a functional joint.

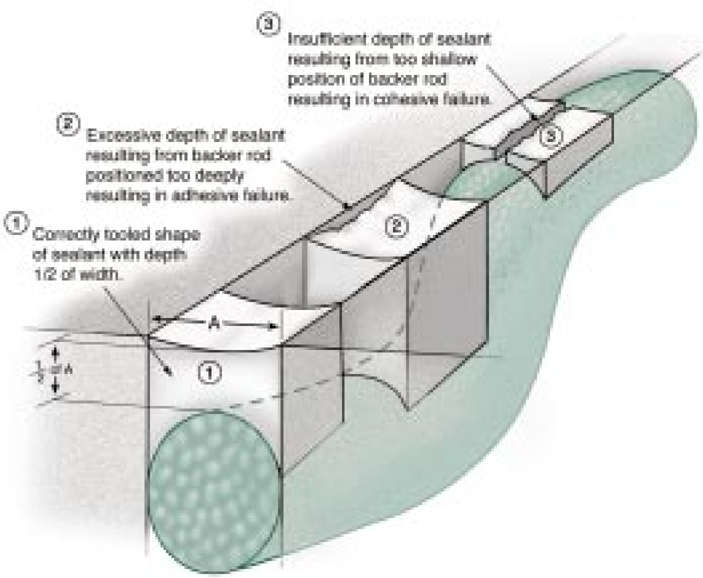

Figure 2: Shows need for correct positioning and sizing of backer rod and correct shaping of sealant.

Enhancing positive traits while eliminating or reducing negative traits by combining different species, materials, or technologies is called hybridization and the end products are called hybrids. As the limitations of individual technologies become apparent, hybrids often emerge to create more effective products. Such new products preserve the best features of the component materials while eliminating the weaknesses that caused the original technologies to stagnate.

A modern-day example of where hybridization is succeeding where individual technologies have stalled is in the development of alternative-fuel vehicles. Internal combustion engines, in their current form, have a limited long-term future due to inefficiency and negative environmental impact. Battery-driven, purely electric vehicles to serve mainstream use are still not viable due to limitations of current battery technology and the hassles of recharging. Available on the market this year are high-performance vehicles powered by highly efficient internal combustion engines and battery-powered electric motors (working in combination or alone depending on driving conditions). These hybrid vehicles feature a sizeable leap in fuel efficiency and are less polluting.

Liquid Sealants

Liquid sealants are supplied in tubes, pails, sausages, or in other ways convenient for shipping. They are extruded through a nozzle into joint-gaps over a pre-placed foam backer rod. The installer then tools the sealant against the backer rod to achieve the "hour-glass" cross-sectional shape needed for handling extension and compression movement. The achievement of this "hour-glass" shape is critical to the performance of the liquid sealant once it has cured into a solid plastic state. (See Figure 1).

Preformed Sealants

Impregnated, open-cell foam sealants are a type of preformed material. They are produced by partially filling the cells of high quality open-cell polyurethane foam with non-drying, water-repelling adhesive agents. The combination of this impregnation treatment followed by compression creates a sealant material that is always in compression. Preformed sealants, by contrast, are supplied ready for installation in their finished, functional state.

Limitations of Liquid Sealants

The major limitation of liquid sealants is the presence of tensile stresses at the bond line and within the body of the cured sealant during extension movement. The negative effect of these tensile stresses is aggravated by installation of the liquid sealant in other than the specifically required geometry. (See Figure 2). Alteration of the geometry as well as changes in the sealant-material state as the result of movement in the joint-gap prior to full cure further limits the functionality of the finished product.

Limitations of Impregnated Foam Sealants

The major limitations of impregnated foam sealants historically have been the need for correct sizing to maintain a suitable level of compression for sealing, the relatively high up-front cost of the products, and the lack of color choice.

Attention to sizing as an objection should be put aside as the same practice is necessary when installing liquid sealants if the goal is a functional sealant. (You cannot install 25mm (1-inch) backer rod into a 40mm (1 ½") joint-gap, tool liquid sealant over it and expect to achieve the necessary geometry for the sealant to function).

The color selection of standard impregnated foam sealants, black or gray, is widely incorporated in design to create a shadow-line effect. However, when the aesthetic effect preferred is to make the material blend or coordinate with the color of a substrate, then this limited selection becomes an issue.

The Big Question

"What if one could develop a sealant that uses the best features of both liquid sealant and impregnated foam sealants AND eliminates their weaknesses?" This question was answered by the development of the current hybrids on the market and it continues to drive development of others to suit more and more applications.

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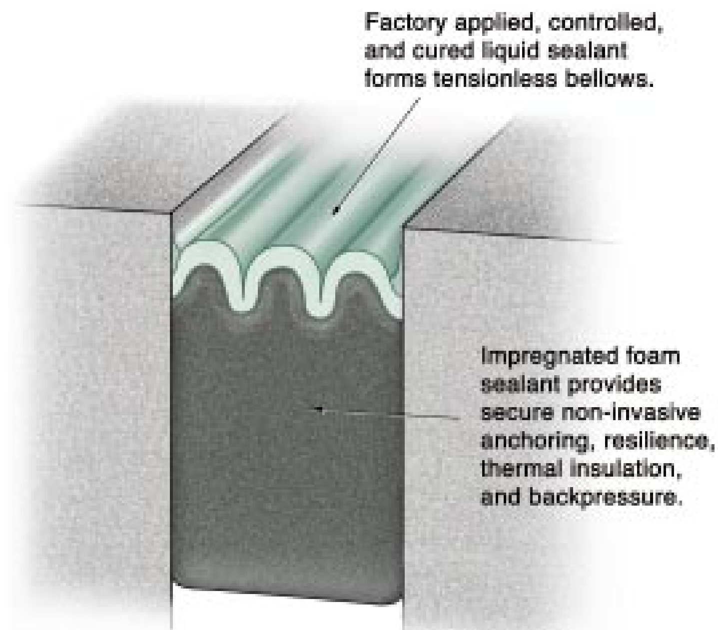

Figure 3: Composition of silicone/impregnated foam hybrid seal.

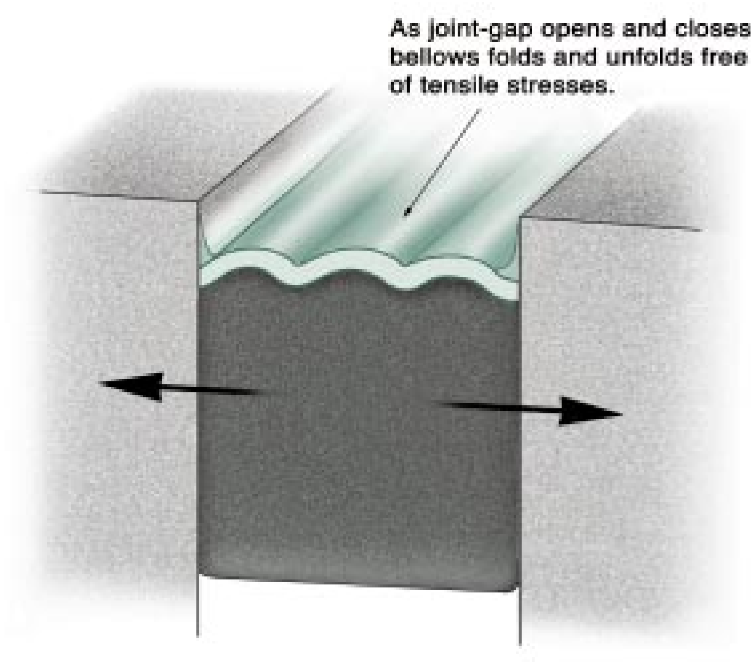

Figure 4: Hybrid sealant in extension. Silicone bellows unfolds free of tension either at the bond line or within the material.

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Composition of Hybrids

Figure 3 shows impregnated foam sealant combined with factory pre-applied silicone liquid sealant in the form of a bellows. The result is to make the best possible use of the two kinds of sealant material while eliminating the disadvantages of both.

The opening and closing movement of the joint-gap (see Figure 4) results in the surface sealant folding and unfolding (rather than stretching and compressing) thereby eliminating substrate bond-line stresses and failure or composition changes caused by pre-cure joint-gap movements.

The seal is made by partially factory compressing the foam followed by the application of the silicone. The silicone coating is applied to a factory-controlled thickness. It is then cured under controlled conditions free of dirt, temperature change and movement of the substrates during cure. Once the silicone coating has cured, the material is compressed to an installation dimension comfortably less than the field-measured joint-gap size. It is held in this pre-compressed state by its packaging until immediately prior to insertion in the intended joint-gap (see Figure 5).

Installation involves essentially insertion of the factory-made "stick" into the joint opening. A corner-bead of liquid silicone locks the bellows to the substrate.

Figure 5: Hybrid silicone/impregnated foam sealant is inserted into joint-gap.

Liquid Sealant (silicone)		Impregnated Foam Sealant	
Disadvantage	Advantage	Advantage	Disadvantage
Tensile stresses on bond line	WIDE COLOR RANGE	ALWAYS IN COMPRESSION	Color choice limited to black and dark gray
Tensiles stresses within cured polymer	MOISTURE IMPERMEABLE	MOISTURE IMPERMEABLE	Movement range of +25%, -25% (Total 50%) of nominal material size
Need for field forming of "hour-glass" performance shape	LOW MODULUS	NON-INVASIVE ANCHORING	Perceived cost
Intolerant of movement in joint-gap before sealant cures into proper shape	RETAINS PHYSICAL PROPERTIES WITH AGE AND OVER TEMPERATURE CHANGE	RESISTS AIR PRESSURE DIFFERENTIALS	Need to maintain compression through careful sizing
Inability to handle large movement joints	UV STABLE	THERMALLY INSULATES	
Tensile stresses on bond line	TOTAL MOVEMENT CAPABILITY EXCEEDING 100% OF NOMINAL JOINT SIZE	SUPPLIED IN VIRTUALLY FINISHED, FUNCTIONAL STATE	

Hybrid Sealant

WIDE COLOR RANGE
MOISTURE IMPERMEABLE
LOW MODULUS
RETAINS PHYSICAL PROPERTIES WITH AGE AND OVER TEMPERATURE CHANGE
UV STABLE
ALWAYS IN COMPRESSION
NON-INVASIVE ANCHORING
RESISTS AIR PRESSURE DIFFERENTIALS
THERMALLY INSULATES
SUPPLIED IN VIRTUALLY FINISHED, FUNCTIONAL STATE
TOTAL MOVEMENT CAPABILITY EXCEEDING 100% OF NOMINAL JOINT SIZE

Figure 6: Summary of advantages and limitations of liquid and preformed sealants and the resulting combination of advantages in the hybrid.

The result is the installation of a system which:

1) Is watertight
2) Moves free of tensile stresses at the bond line
3) Moves free of tensile stresses within the material
4) Is anchored without drilling
5) Is anchored positively by 3 means: its mechanical backpressure; the pressure-sensitive adhesion of the impregnation agent; and by the corner bead
6) Combats spalling of the substrate by virtue of its backpressure
7) Is resilient and therefore resists the effects of air-pressure differentials
8) Thermally insulates
9) Is difficult to vandalize
10) Is cost-effective on installed-cost basis
11) Is cost-effective on long-term performance basis.

The enclosed chart (Figure 6) summarizes the merits and de-merits of both basic kinds of sealant and the dramatic advantages of the hybrid combination of both types.

Figure 7: Silicone liquid-sealant and impregnated foam hybrid in hard-to-seal outside radius of skylight system.

Conclusion

Hybrid sealants available today shine in many applications including:

1) movement joints,
2) large joints over 25mm (1-inch),
3) where resilience or the need to resist air-pressure and thermal differentials is essential,
4) anywhere a structural or new-to-existing gap needs filling and sealing.

Because of their non-invasive anchoring, watertightness, color choice, and tensionless movement, the hybrid bellows sealants outperform liquid sealants or traditional impregnated foam sealants alone and excel in installation and performance over extruded-rubber compression seals and particularly combination metal rail and rubber gland "strip seals".

Small-size hybrids for mass production and for use in window and panel perimeters are under development and promise to make their use as cost-effective as current liquid-sealant and backer rod options. Under development throughout the world, other hybrids include:

1) combinations of chemically-resistant liquid sealants and impregnated foam sealants for use in wastewater, caustic and other harsh environments;
2) combinations of materials to provide fully fire-rated, watertight movement joints;
3) combinations of hydrophilic or hydrophobic materials with impregnated foam sealants to handle below-grade and head-of-water applications.

Whether in the cattle business in the 1800's, the space race in 1960's or in the sealant, waterproofing and building restoration industry in the new millennium, as long as problems continue to exist, innovation is inevitable. As long as there is innovation, hybrids will develop because very often the solutions to problems we face lie not in the search for radically new materials, but in the creative combination of existing technologies.

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